Addressing Material Efficiency in Building Renovation Scenarios

A BIM-based decision support tool

Sara Parece

Sara_parece@iscte-iul.pt

Supervisor(s): Ricardo Resende[1], Vasco Moreira Rato[1]

1. Instituto Universitário de Lisboa (ISCTE-IUL), ISTAR, 1649-026, Lisboa, Portugal

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Introduction

Europe's building stock is aged and characterized by low energy performance, which has led to an increase in **building renovations**, which remain inefficient regarding time, cost, and material use.

High-performance renovations can reduce a building's life cycle impact, but they cannot rely solely on energy efficiency strategies. A balance between operational and embodied GHG emissions is essential.

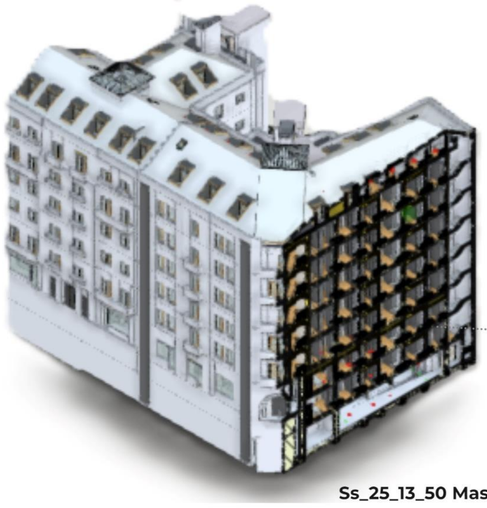
Life Cycle Assessment (LCA) is a reliable method for measuring the environmental impact of building products throughout their life cycle, encompassing all emissions. Nevertheless, due to the extensive information required, it can be **complex, time-consuming and costly**.

Building Information Modeling (BIM) has become the go-to strategy for LCA as it reduces manual tasks involved by automating detailed quantity extraction. However, there are still **challenges**, especially in renovation projects.

Objective

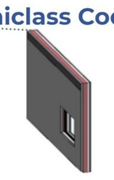
Define and test a BIM-based framework for Life Cycle Assessment (LCA), Life Cycle Cost Analysis (LCCA), and Circular Economy analysis to support informed decision-making for renovation scenarios from the early design phase.

Method



BIM Model

Uniclass Code



Ss_25_13_50 Masonry wall systems

Specifications Database

Uniclass Code

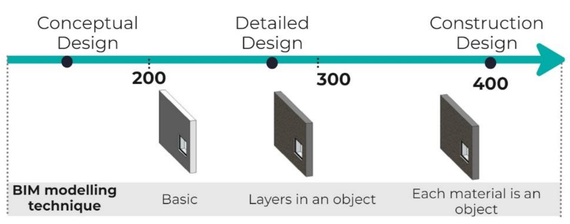
Expected lifespan
Unit of Measure
Conversion Factor
Unit Cost
Unit Manteinance Cost
Relative material quantity
U-value

LCA Database

Uniclass Code

Embodied Carbon
Design for Dissasembly

Scope



This method establishes three QTO methods, considering t the LoD, the information granularity and the BIM modelling technique for each BIM element.

Quantity take-off depending on the LoD

Catalog of potential interventions

Uniclass Code

A machine-readable catalogue that includes potential interventions in late-century Lisbon building stock.

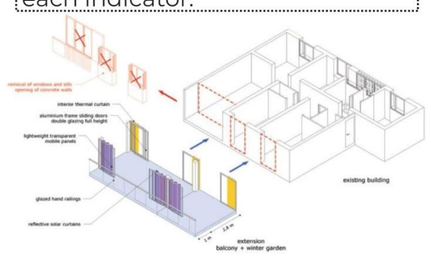
Optimization

Optimization algorithm to sugest the optimal solution based on user preferences

Benchmark minimum and maximum values for each indicator.

Indicators Calculation

- Embodied Carbon
- Operatinal Carbon
- Design for Dissasembly and Adaptability
- Life Cycle Cost



Report

Download the Embodied Carbon Calculator

Participate in the Survey on BIM-based LCA

Read the most recent publication

Challenges

1. LCA is often performed when all data is available at the end of the design process, **limiting its potential to influence high-impact decisions.**

2. Current BIM-LCA tools do **not allow continuous monitoring of environmental impacts**. They focus on one or two design phases, forcing users to switch tools and lose information.

3. BIM-LCA is **not adapted for renovation or refurbishment projects**, including the specific BIM modelling methods, leading to **interoperability issues**

4. Lack of **decision-support to guide trade-offs between conflicting objectives**, such as balancing cost and embodied and operational carbon.

Preliminary results

- Embodied Carbon calculator adapted to early and developed design stages.
- Survey for Construction Stakeholders on the Current State of BIM-based LCA in the European Construction Sector.

Future developments

- Incorporate circular economy indicators into the proposed framework.
- Develop a machine-readable catalogue that includes potential interventions for late-century Lisbon's building stock.
- Conducted case studies and simulated different design options.
- Apply optimisation algorithms to find optimal solutions based on multiple criteria.

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